Cities on Volcanoes 9
November 20-25, 2016
Puerto Varas, Chile
'Understanding volcanoes and society: the key for risk mitigation'

A New Technique for Measuring Surface Profiles of Debris Flows Occurring after Volcanic Eruptions

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Keywords: debris flow, field observation, laser profile scanner, free–falling nappe, Sakura–jima volcano

It is commonly known that debris flows occur with very high frequency after volcanic eruptions because the rate of rainfall–runoff will increase on the slopes covered with tephra deposition. These debris flows may cause serious damages on human properties and lives, so that it is necessary to prevent them from plunging into residential area. Therefore, understanding dynamics of debris flows in volcanic areas is severely required. However, the field measurements of physical state of debris flows is one of the difficulties because of very high momentum of flows and hazardous risks at the sites. To measure longitudinal and cross–sectional profiles of debris flows safely and precisely, the authors installed laser profile scanners (LPSs) at a check dam in Sakura–jima volcano located in southern part of Japan, where the volcano erupts frequently. The LPS can measure 2–dimensional surface geometry with the resolution of 0.25 degrees in angular and 0.05 seconds in time, and two LPSs are attached to an arm 8.4 m above the spillway to observe longitudinal and cross–sectional profiles of debris flows falling out from the check dam. In this study, a debris flow discharge occurred on December 10, 2015 is investigated by using exit water depth at the spillway and projectile distance from the check dam to the reference plane arbitrary defined. The semi–theoretical formulation for drop length of free–falling nappe is introduced to estimate the flow velocity of the debris flow and the authors have obtained time series of flow velocity with very high resolution in time. This measuring technique can be quite conducive to understand dissipation caused by turbulent and constitutive of debris flow, and also the relationship between rainfall–runoff and hydraulic characteristics of debris flows.